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Paper Presentation

Moving Object Detection With Genetic Programming

Background

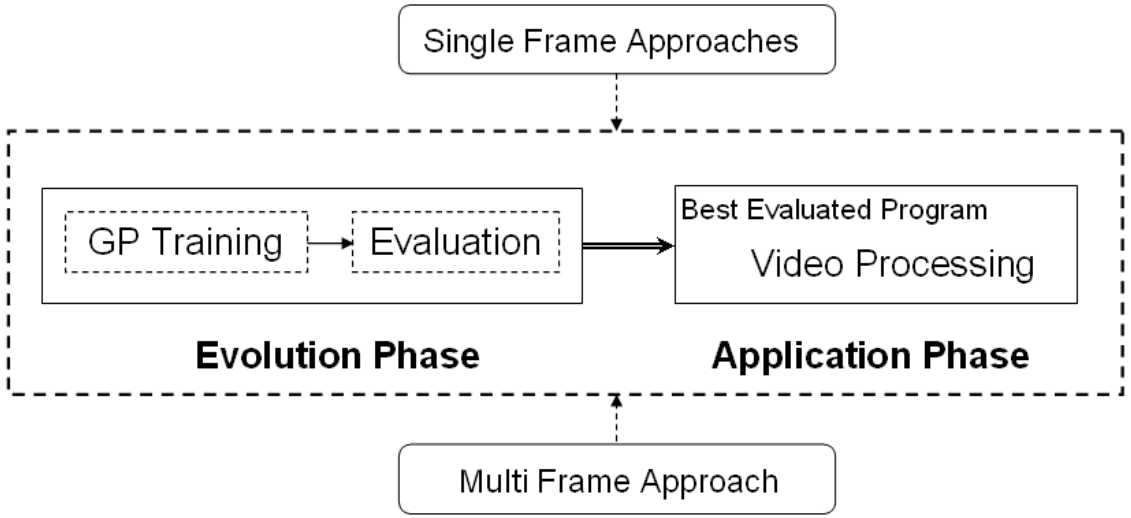
- Surveillance
- Human-Computer Interaction
  - http://www.betatechreviews.com/wp-content/uploads/2011/10/microsoft_kinect_kids_playing1.jpg

- RoboCup Soccor
  - http://i.telegraph.co.uk/multimedia/archive/01436/Red-and-blue_1436364i.jpg

- Thresholding:
  - Intensity, Color
- Hardware:
  - Specialized lighting
  - Specialized ranger
- Requires constant adjustment

Methodology

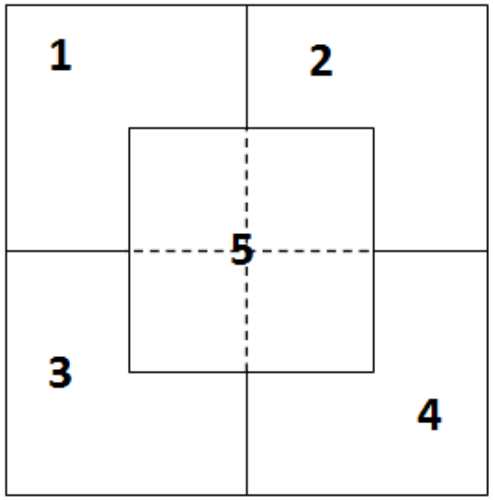
- Overview:



- Evolution Phase = Training
- Image scanner
  - Windowed
  - Two regions
    - Object
    - Background

Methodology GP Training

- Image Quantifiers Single Frame
  - Pixel Intensity: grayscale [0 100]
  - Pixel Color: RGB
    - *Hue* = [0 359]
    - Ranged to [-1 1] using *sin()*
  - 12 Features
    - f[1-5]: average intensity of each region
    - f[6]: (f[1]+f[2]+f[3]+f[4])-4*f[5]
    - f[7-12]:
      - f[7]=mean(f[1], f[2])
      - f[8]=mean(f[1], f[3])
      - f[9]=mean(f[1], f[4])
      - f[10]=mean(f[2], f[3])
      - f[11]=mean(f[2], f[4])
      - f[12]=mean(f[3], f[4]);



Methodology GP Training

- Image Quantifiers Multi Frame
  - Motion plane = MP

$$= \frac{\sum_{i=1}^{n-1}((x_i - x_{i-1}) * (n - i))}{n}$$

x = frame # n = total # of frames in Motion plane

  - MP provides
    - Change of pixels in [n] frames
    - High MP indicates moving object
  - MP is good better suited for a stationary background

Methodology Evaluation
GP settings

- Function Set

Function	Return Type	Arguments
+	Double	Double, Double
-	Double	Double, Double
×	Double	Double, Double
/	Double	Double, Double
=	Boolean	Double, Double
<	Boolean	Double, Double
>	Boolean	Double, Double
if	Double	Boolean, Double, Double
between	Boolean	Double, Double, Double

- Terminal Set

Terminal	Return Type
drand	Double
Att[x]	Double

- Evolution Settings

Population Size	200
Maximum Depth	12
Minimum Depth	2
Generations	150
Mutation Rate	0%
Crossover Rate	90%
Elitism Rate	10%

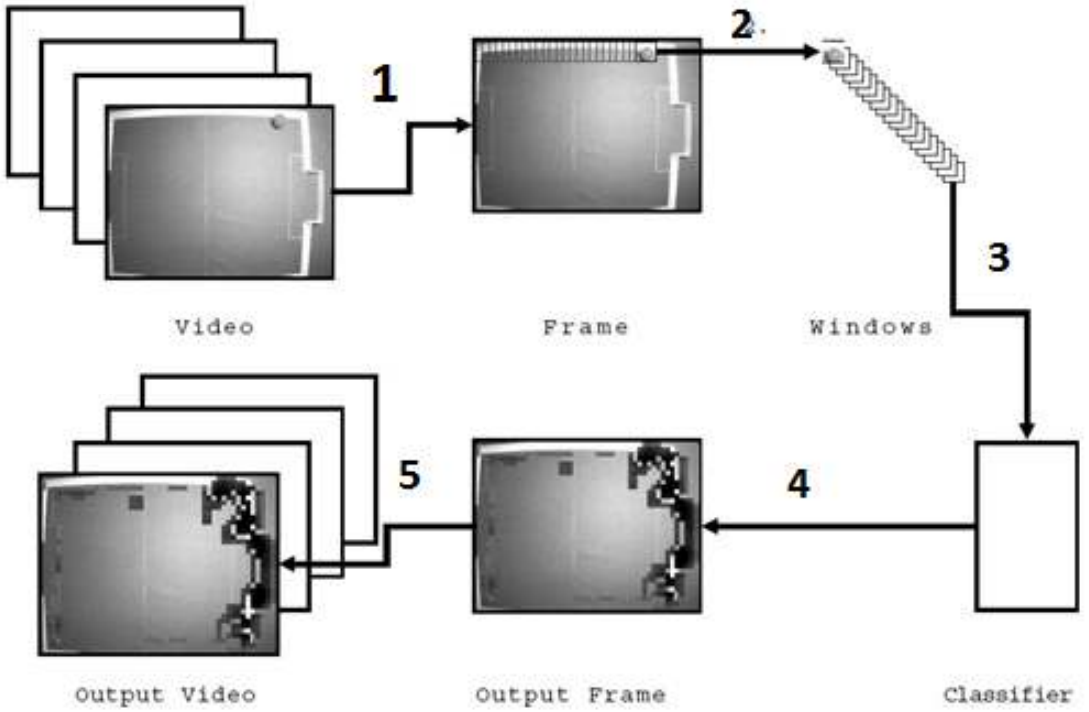
Methodology Evaluation Training Data

- Positive
  - Ball located near center of frame
- Negative
  - Ball out of center
  - Variations of color ≠ Ball color

1. Best GP selected from each training set
2. Best GPs evaluated
3. Optimum GPs from evaluation used in application

Methodology Application

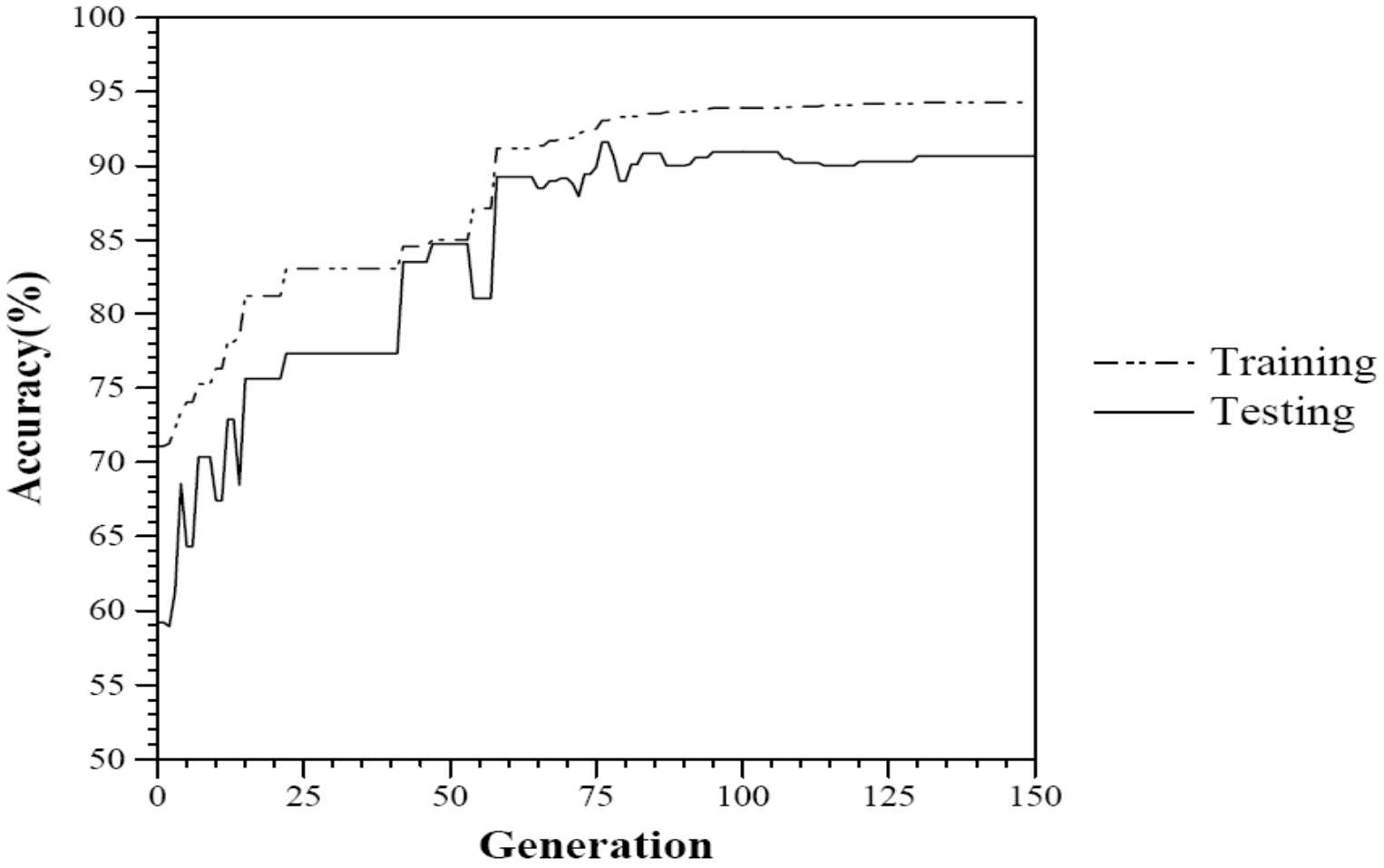
1. Retrieve current frame from video
2. Use window to sample frames*
3. Classify these windows using optimum GP
4. Assemble labeled windows back to frame**
5. Output processed frames continuously as video.



* Most pixels are sampled multiple times due to overlap

** Voting is used to classify these pixels.
Pixel A sampled 3 times = ball
Pixel A sampled 9 times = not-ball
Pixel A ← not-ball

Results


100
95
90
85
80
75
70
65
60
55
50
Accuracy(%)
0
25
50
75
100
125
150
Generation
Training
Testing

Results

- Pixel Intensity
  - Error ≈ **5%**
  - False Positive ≈ [**2.5% 5%**]
- Color Values
  - Error ≈ **10%**
  - False Positive ≈ [**8% 10%**]
- Feature Values
  - Error ≈ **15%**
  - False Positive ≈ **14%**
- Motion Plane
  - Error < **2%**
  - False Positive < **1%**

Pixel Intensity		
Condition	Accuracy	FP Rate
Three Halogen Lights	96.15%	2.59%
Two Halogen Lights	95.33%	2.66%
One Halogen Light	94.92%	5.08%

Color Values		
Condition	Accuracy	FP Rate
Three Halogen Lights	89.29%	9.53%
Two Halogen Lights	91.31%	8.04%
One Halogen Light	88.48%	10.48%

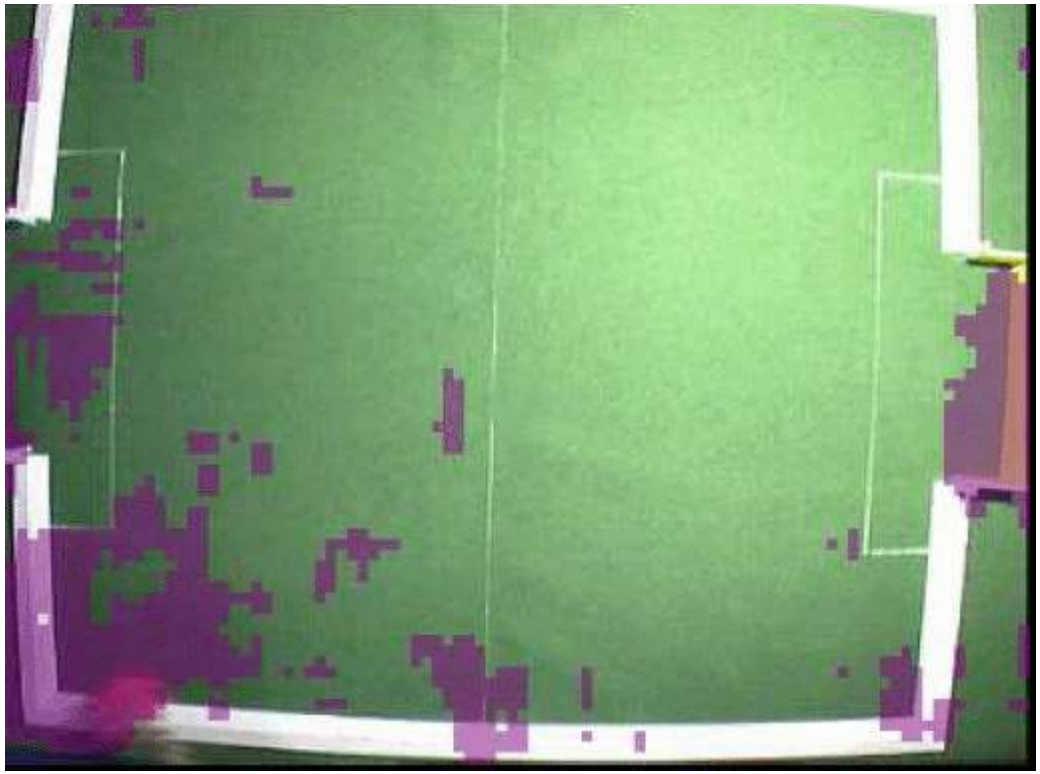
Motion Plane		
Output Frame	Accuracy	FP Rate
Three Halogen Lights	98.18%	0.28%
Two Halogen Lights	98.59%	0.16%
One Halogen Light	98.18%	0.83%

Results

- Pixel Intensity, One Halogen
  - **Accuracy = 94.92%** **False Positive =5.08%**

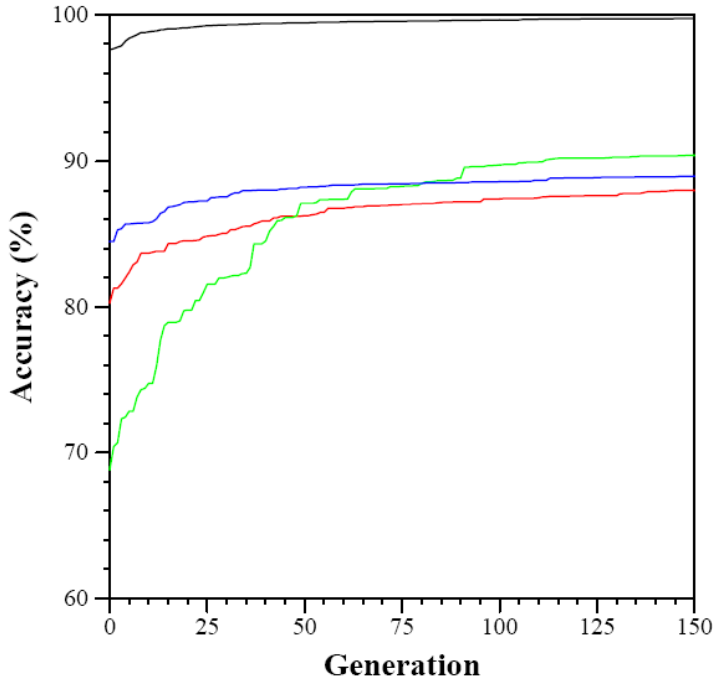
Results

- Color Value, One Halogen
  - **Accuracy = 88.48%** **False Positive =10.48%**

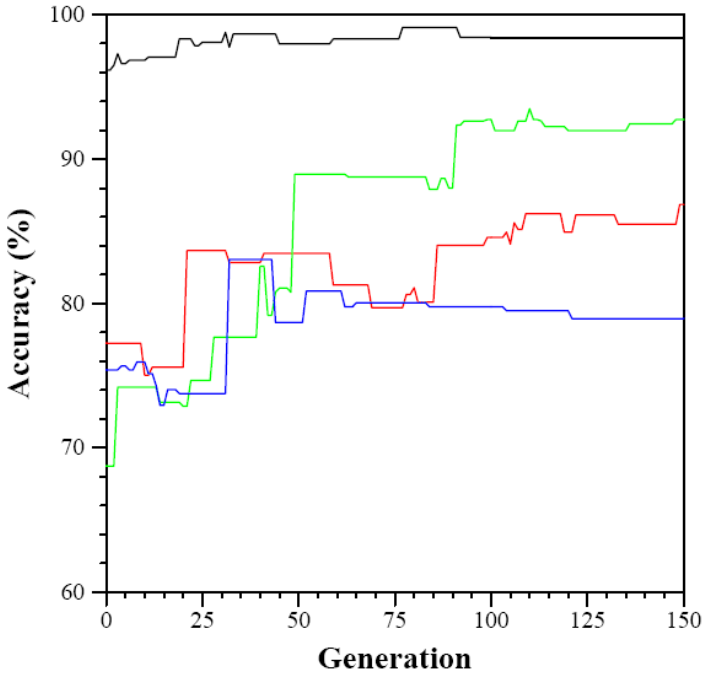


Comparison
Motion Plane VS Feature Approach

- Training



Evaluation

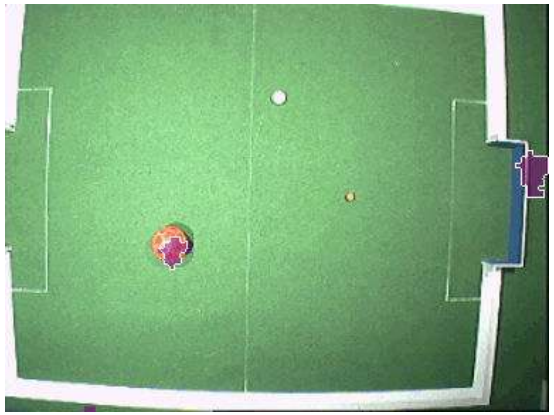


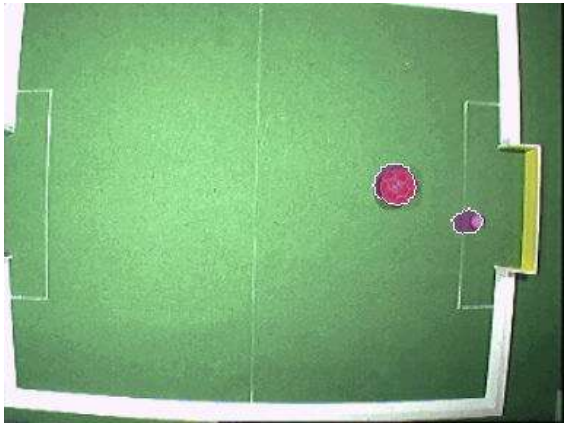
- Key: Motion plane —— and ——

  Feature —— and ——

Comparison
Speed & Intensity vs Motion Plane

- Speed
  - GP small → Efficient Runtime
- Intensity VS Motion Plane
  - Pixel Intensity only identifies biggest object
  - Motion plane identifies multiple objects of varying size





Reference

- Andy Song , Danny Fang, "Robust method of detecting moving objects in videos evolved by genetic programming," *Proceedings of the 10th annual conference on Genetic and evolutionary computation*, July 12-16, 2008, Atlanta, GA, USA